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The Rural Clean Water Program: A Report

About the Author

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Note

This report provides an overview of the Rural Clean Water Program for the nontechnical reader concerned with issues of environmental and agricultural policy. For statistical details, especially on monitoring, the reader may wish to consult *Status of Agricultural Nonpoint Source Projects,* prepared annually by the National Water Quality Evaluation Project at North Carolina State University. It is available from the project's offices at 615 Oberlin Road, Suite 100, Raleigh, NC 27605-1126. Telephone (919) 737-3723. The project's staff also publishes various other technical papers on the RCWP and keeps complete files on individual projects as well.

"Opinions expressed in this document are those of the author and do not necessarily reflect USDA policy."

The Rural Clean Water Program: A Report

United States Department of Agriculture

Soil Conservation Service

Agricultural Stabilization and Conservation Service

Forest Service

Extension Service

Agricultural Research Service

Economic Research Service

Rural Electrification Agency

United States Environmental Protection Agency

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Part I: The Program

In Vermont these days, farmers in the northwestern part of the State are keeping an eye on waterfront real estate prices along beautiful St. Albans Bay, an arm of Lake Champlain, even though few of them own property there.

In Iowa, the color of the water—now brilliant blue—in a 220-acre recreational impoundment called Prairie Rose Lake, set in the midst of corn and soybean fields, seems to be making all the difference.

In Florida, the health of a small creature called the apple snail, which lives in the lily pads of Lake Okeechobee and is the favorite food of the Everglades kite, an endangered species, has claimed the attention of dairy operators who do not think of themselves as ecologists but as business executives, which they are.

In coastal Oregon, the happiness of clam diggers and the profitability of a couple of commercial oystering operations in Tillamook Bay seem to be the crucial factors for local dairy operators and their creamery.

In the tumbling waters of Rock Creek, a tributary to the Snake River in Idaho, the return of native rainbow trout is the subject of talk in the coffee shops where cash-grain farmers gather.

Topics like these may not sound as though they have anything to do with modern agricultural practice, but they do. The price of waterfront real estate, the blue of a lake, and the presence of the apple snail and the native trout exemplify the tangible results of a remarkable 10-year effort now nearing its conclusion: the Experimental Rural Clean Water Program, which was meant to develop the means to make the waters of rural America clean and pure once again and to do so in a way that, while requiring farmer participation, does not threaten the delicate economics of farms and farm districts.

"Nonpoint" and Agriculture

Historically, water pollution has been thought of as a phenomenon of cities and heavy industry. Even today, people tend to conjure up images of raw-sewage outfalls, of oily rivers catching fire, of Lake Erie dead or dying along its factory-lined shore, of unspeakable wastes turning stream water to garish hues in industrial districts on the outskirts of cities.[1]

In contrast, there was the "pure" country, to which all pollution-ridden urbanites and those who lived near factory gates in America wished to escape—for a weekend at least, maybe permanently.

It was only quite recently, during the 1960's and 1970's—the years of "environmental awakening"—that Americans discovered the waters of the pure countryside to be polluted too. Far from the big-city sewer pipes and noxious industrial drainageways, rural lakes and streams were found to be laced with pesticides, algae-green because of excessive nutrients from animal wastes and fertilizers, clouded to mud-puddle opacity from suspended solids, and unsafe to drink because of rising fecal coliform bacteria counts, not from cities but from livestock. According to a 1977 study by the U.S. Environmental Protection Agency,[2] such pollution affected the water quality of some 68 percent of the drainage basins in the United States. In the erosion-prone Corn Belt, 90 percent of the basins were so affected.

Because of this phenomenon, a new word had to be invented for dealing with water pollution—"nonpoint," meaning pollution that does not emanate from, say, a sewer pipe (a point), but rather from diffuse sources, such as a farmer's field (a nonpoint). Agriculture is not the only nonpoint source. Construction, mining, runoff from streets, and forestry, among others, contribute a share. But agriculture is the major factor. "By far the most common nonpoint source [of pollution] reported by States in

Runoff loaded with dairy wastes causes unrestrained growth of weeds and algae. This process, known as eutrophication, lowers recreation quality, kills fish, and can make the water unsafe for drinking.

1986," says a recent EPA report, "is agricultural runoff." The report points out that agriculture is "the primary pollutant source for 64 percent of affected [polluted] river miles, 57 percent of affected lake areas, and 19 percent of affected estuarine areas" in the United States.[3] A study of "nonpoint-source loadings" by the National Commission on Water Quality projected that even after all the point sources are remedied, as many now have been, nonpoint sources (mainly agriculture) will still produce 72,500 tons per day of suspended solids (sedimentation), 14,150 tons per day of nitrogen, 965 tons per day of phosphorus, and virtually all of the remaining fecal coliform pollution.[4] A study by the Association of State and Interstate Water Pollution Control Administrators revealed that in 35 of 50 States nonpoint source pollution from agriculture was identified as a problem.[5] The answer to the crisis of agriculturally polluted water in rural areas obviously cannot be the same as the answer to point source pollution, such as tertiary sewage plants for municipalities and waste recycling for factories. Yet, some of the principles can be borrowed and joined with traditional agricultural management techniques to limit, if not eliminate, agricultural pollution.

Best Management Practices

The water pollution control effort has popularized another vague term of art — "best management practices" — that describes a wide range of techniques to reduce agriculturally caused nonpoint source pollution. The Experimental Rural Clean Water Program was set up to test these techniques in some 20 watershed areas across the country, beginning in 1980. Before describing the origins and workings of this program, however, it is important to explain its primary unit of work, the farm-by-farm installation of best management practices to curb nonpoint pollution.

For example, in cash-grain farming areas of the Midwest, agricultural runoff from rains and snowmelt can carry an incredible amount of soil from the fields, along with nutrients and pesticides. This is what was happening to Prairie Rose Lake in Iowa. The water, a brown so murky not even algae could bloom, was no longer swimmable or fishable. Sediment had consumed nearly a fifth of the 220-acre lake's volume.

To deal with such a problem, in Iowa or elsewhere, a "best" management practice might be as old-fashioned as contour plowing and stripcropping to reduce runoff. Contour plowing creates, in effect, a series of tiny check-dams, with the plow furrows running across a slope rather than up and down it. Stripcropping — planting alternating strips of different crops, also along the contour — can, with contour plowing, reduce runoff up to 50 percent. Terracing is another old method, dating back thousands of years in the Orient and the Mediterranean region, and still useful, though it is a labor-intensive (now machine-intensive) method. Grassed waterways to reduce gullying from runoff, and filter strips — permanent bands of natural vegetation that can intercept runoff water and its agricultural pollutants before they enter a stream — are effective practices as well.

Prairie Rose Lake, once polluted with sediment and agricultural chemicals, is again a major tourist attraction in Iowa.

All of these techniques, in varying combinations, were put into practice by Prairie Rose Lake farmers, as was conservation tillage. In conservation tillage, the soil is not turned, and crop stubble and other residues are left on or near the surface to retard runoff.[6]

Conservation tillage was also a best management practice selected to deal with the pollution problems in Idaho's Rock Creek project, along with new ditch irrigation and catchment techniques. The main problem with ditch irrigation is that the return flows — the water from irrigation returning to a stream or water body after coursing through a field — are laden with silt and nutrients.

A demanding and complicated set of best management practices is also needed to reduce the runoff of animal wastes from dairying and, to a lesser extent, from cattle ranching and other stock-raising operations. In the St. Albans Bay area of Vermont, for example, an alternative to the year-round spreading of manure on fields had to be found because the manure would simply accumulate in great quantities on frozen ground in the winter, then wash into the bay at spring thaw. Here, the "best" practice was the construction of a manure pit, often with a secondary pond to draw off and store liquid wastes that could later be sprayed on the fields. The result could make a significant difference in the town's tax rolls, with the price of waterfront property on the

This turbulent fountain, or "bubble screen," filters from water the debris that could clog gated irrigation pipes and siphon tubes.

bay given a boost through reduced amounts of algae in the bay.

Around Lake Okeechobee in Florida, where some of the largest dairies in the world are located (5,000-head herds), much more elaborate waste management systems had to be constructed. In one watershed area, computer programs were developed to help assure that solid and fluid wastes were not put on fields when the water table was high (as it often is in Florida), which would inhibit the nutrients being taken up by the soil. The next rain would simply move the wastes into the streams and thence to the extremely eutrophication-prone Lake Okeechobee. An associated technique used by the Okeechobee farmers and ranchers, in these concentrated dairy livestock operations, was the fencing of streams in which cattle like to "lounge" on hot days, of which there are many in this semitropical climate. To keep livestock cool, portable cattle shades were provided.

In the Tillamook Bay area of Oregon, the problem was rain — a hundred inches a year that swiftly and routinely washed animal wastes into the bay from the dairies providing the milk for famed Tillamook cheddar cheese. The high nutrient and bacteria content of the effluent threatened the local oyster industry and threatened, too, to reduce tourism, a primary concern here. In Tillamook, the best management practices employed included building covered manure sheds that would store up to 90 days' accumulation of wastes. This meant that farmers would not have to spread manure during rainy weather, but could wait till the skies cleared. In addition, extremely elaborate systems were devised for separating fresh water from contaminated water, using guttering, curbing, and the like so that clean water from the rains could be diverted into the bay. The contaminated wastewater was collected for spraying on pastures via manure-slurry spray pumps or the traditional "honey wagons," which each spring lend the city of Tillamook a distinctive agricultural atmosphere.[7]

Origins and Workings of the Program

As a statutory program of the U.S. Government, the Experimental Rural Clean Water Program (usually, "experimental" is dropped and the initials RCWP used) can trace its origins to the Federal Water Pollution Control Act Amendments of 1978, one of the most far-reaching pieces of environmental legislation ever enacted by the Congress. Not only did it challenge the idea that a proper use of virtually all surface water was to carry away or dilute manmade pollution, this act, Public Law 92500 (popularly called the "Clean Water Act"), demanded for the first time ever in Federal law that water pollution resulting from the general use of land be abated, even if it meant modifying land use. Section 208 of the 1972 act provided that States prepare statewide and regional plans, based on watersheds, not only for "point sources," but also for the prevention of what it called "nonpoint" source pollution. A new word then, but no longer.

The broad mandate of section 208 notwithstanding, the main activities taking place with respect to water pollution had to do with funding municipal sewage plants and cleaning up industrial discharges. Rural watershed planning took place, but not much action ensued.[8] Then, in 1977, when it came time for Congress to amend the Clean Water Act, Senator John Culver of Iowa proposed that a sharply focused program be instituted to assure that rural nonpoint source pollution would be addressed as decisively as urban point source pollution. The Culver amendment, so-called, was the Rural Clean Water Program. The amendment sought to provide the wherewithal for farmers to initiate the management practices needed to reduce the agricultural industry's substantial contribution to rural water pollution. It was, in effect, a public works funding program that would apply to private farms and ranches in rural watersheds, as a parallel effort complementing the funding of municipal sewage districts in towns and cities. The Culver amendment was adopted as part of the 1977 Clean Water Act amendments, and $600 million was authorized. Later amendments, enacted in 1980, extended the authorization for two more years and brought the grand total to $800 million.

But the program as originally conceived remained unimplemented, the generous authorization unappropriated.

One of the sticking points was the amount of money involved. The Carter administration was trying to fight inflation and, therefore, kept a close watch on all funding programs. Later, an incoming Reagan administration would be calling many social and environmental programs into question from the standpoint of reordering Federal spending priorities in favor of national defense.Yet this was not the whole reason Senator Culver's program languished. At the most elementary level, before the program was enacted, a basic choice had to be made between the U.S. Environmental Protection Agency, as the traditional implementer of pollution control programs, and the U.S. Department of Agriculture, as the implementer of farm programs. EPA was already involved with best management practices that could be applied to clean up rural water, but USDA had been working closely with farmers for 50 years on techniques to abate soil erosion, the primary cause of agricultural nonpoint source pollution, and had an elaborate local administrative structure already in place. On that basis, USDA got the nod from Congress.

Within USDA, however, there was indecision as to which agency should direct the program — the Soil Conservation Service, whose

technical expertise in management practices was paramount, or the Agricultural Stabilization and Conservation Service (ASCS), which had always handled the money for price supports and for conservation cost-share programs through the Agriculture Conservation Program, first established in 1936.[9] Initially, Congress appointed SCS as the lead agency, though ultimately changing its mind in favor of ASCS. The lead-agency disagreement lasted two years; rules and regulations for the program were issued, then withdrawn, then finally reissued. But by then, the point was moot. The environmental 1970's were over. There was no chance that a big-money allocation would be made by Congress to clean up rural water.

By that time, 1980, it seemed to many that the program might be lost altogether. Then, Representative Jamie Whitten of Mississippi, long a major figure in the Congress on agriculture policy, stepped in with the idea of establishing an experimental rural clean water program, which could be mounted for only a fraction of the cost of the original. As chairman of the budget subcommittee allocating funds, Whitten made the program part of the 1980 Agriculture Appropriation Act, rather than wait for the next go-round on the Clean Water Act. The 1980 Agriculture Appropriation Act (now Public Law 96108) provided "for necessary expenses for carrying out an experimental Rural Clean Water Program, $50,000,000, . . . to be targeted at areas with identified and significant agricultural nonpoint source water pollution problems."[10] One year later, another $20 million was added through a supplemental appropriation.

The program developed with this total of $70 million was mounted in (ultimately) 20 watersheds across the country, most of them drawn from some 80 early applicants to the original, unfunded RCWP. The watersheds, ranging in size from a few hundred acres to several hundred thousand, were meant to be geographically distributed and reflective of various agricultural pollution problems—sedimentation, pesticides, excessive nutrients, and fecal bacteria—in irrigated and unirrigated cash grain areas and in dairying and stock-raising areas.

A major erosion-control practice is no-till planting, in which new seeds are sown directly into ground covered with residue from the previous crop.

Although the lead agency was ASCS, the program was to be implemented in the field by SCS, with the involvement of other agencies as needed. EPA was to work in close consultation on the program with the USDA agencies, particularly on monitoring results in terms of reduced pollution after the best management practices had been installed. Others with a seat on the program's National Rural Clean Water Coordinating Committee were to include (and do) the Extension Service, the Economic Research Service, the Agricultural Research Service, the Rural Electrification Agency, and the Forest Service, along with SCS. The ASCS was chair.

Within the designated project areas, a local version of the national group was to carry out the program. Typically, ASCS was to handle the contracts with farmers, with SCS providing the planning and technical expertise for installing the practices. Extension agents would provide agronomic advice (which in some cases is crucial), and scientists from cooperating State water or environmental agencies, or a State university, would handle the monitoring.

The first task for each project was to identify the "critical areas" of the watershed because not all of the land was farmland and not all farmland contributed to the pollution load. After that, farmers could be identified and asked if they would like to participate. If the answer was yes, SCS would then prepare a detailed plan combining the techniques—the best management practices—needed to produce the needed pollution reduction (usually via runoff, though ground water pollution was at issue in some areas) at the minimum possible public cost.

The deal offered to farmers was this: RCWP would pay up to 75 percent of the cost of installing the best management practices recommended in the water quality plan. The farmer would pick up the rest and promise to keep the practices installed for a period of years, usually 10 for expensive practices, such as the construction of a manure storage facility,

down to a minimum of 3 years for practices in which there was little cost involved, such as modifying crop rotations, tillage techniques, or pesticide applications. Cost of the practices ranged from a few hundred dollars for a fence, a drain, a culvert, or conversion to conservation tillage on a small farm, to $100,000 or more for elaborate animal waste management systems that might include concrete manure pits, lagoons, pumping stations, irrigation systems, and the like. The maximum the program would pay to execute a water quality plan, however, was $50,000 per farmer-cooperator.

It was not always easy to convince farmers to participate. For many a small operator, a required expenditure of $15,000 or $20,000 was a major family decision. Moreover, in many areas, contracts were not offered until the agricultural depression hit in 1983, making it impossible for many farmers to cooperate. Nevertheless, as of 1988, farmers had contracted for, if not implemented, best management practices on some 70 percent of the critical areas in the RCWP's 20 experimental watershed areas. A number of areas have achieved nearly 100 percent cooperation from farmers.

Meanwhile, monitoring stations were established. Some were simply designated spots where "grab" samples of surface water would be taken. Others were permanent monitoring stations with highly sensitive equipment that, round the clock, would measure pollutants, rate of flow, depth of water, temperature, and the like for the complex analysis that would take place in the lab later on.

Monitoring was, of course, a crucial element in a program meant to be experimental. Accordingly, five of the projects were designated to receive greater amounts of funding for monitoring (in Idaho, Illinois, Pennsylvania, South Dakota, and Vermont). In other project areas, such as

Monitoring water quality in Vermont.

Lake Okeechobee in Florida, considerable funding and scientific manpower for monitoring work were supplied by the State Government.

The legislation establishing this experimental program, the 1980 Agriculture Appropriations Act, is open-ended. Funds for implementation are "available until expended." As a practical matter, however, the experimental program's effective life is about 10 years, since that is the term of most of the major management practices installed under the cost-share formula. The monitoring component, especially in the areas selected for comprehensive analysis, will continue well beyond the conclusion of the contracts with farmers for the installation of management practices. In a few areas, a change in focus took place midway through the project. For these, monitoring results will not even begin to come in until the early 1990's.

Although some monitoring needs to be completed in many project areas, the experimental Rural Clean Water Program is clearly in its final phase. Virtually all contracts with farmers have been let, and most practices have been installed. Analysis of results is now the primary task, as the effects on ambient pollution by the practices installed become evident.

While relevant passages of the 1987 Clean Water Act will permit additional funding for the current program, if needed, the essential policy question is not whether some of the 20 experimental projects need to be extended (though they probably do), but whether and how the findings of the experimental program can be applied in the Nation's remaining watersheds where nonpoint source pollution from agriculture is a serious matter. Some analysts believe that there may be as many as 600 agricultural watershed areas that have surface water problems requiring the attention given to the experimental 20.[11] What's needed now in order to revisit the "big" decision on the future of rural clean water policy, probably in 1990 when the Clean Water Act comes up again for review by Congress, is a better understanding of what has been going on in the experimental project areas over the last 7 or 8 years.

Part II: The Projects

In order to understand how the experimental Rural Clean Water Program actually works and to get a sense of its significance, it is necessary to see it in operation, to at least glimpse some on-the-ground specifics. Following, therefore, are thumbnail descriptions of the 20 existing projects.[12] Unless otherwise noted, project information in this section is based on local project reports, which are prepared annually; analyses of the National Water Quality Evaluation Project at North Carolina State University; and personal interviews by phone or in person with local project officials. These project narratives can be read collectively or selectively. Each story, like each of the projects, stands on its own. Some sketches required more text than others, but this should not be taken as a measure of a project's overall significance to the program. Projects are organized alphabetically by State.

Alabama:
The Lake Tholocco Watershed

If any experimental project were designed to stress-test the concept of the Rural Clean Water Program, it would be Lake Tholocco. The lake, a recreational impoundment in southeastern Alabama largely within the boundary of a U.S. Army reservation (Fort Rucker), is intensively used for recreation — 100,000 boaters, water skiers, swimmers, anglers, and picnickers a year. When the project began it also suffered from dramatic agricultural pollution, for much of its watershed lies outside the reservation. Sediment loads from upstream farms had already filled in the northern third of the lake. Fecal bacteria from swine operations in the watershed, involving about 4,000 animals, had required that the lake be closed to swimming. In 1979, the year before the RCWP project started here, swimming was prohibited for a total of 85 days.

The problem has been the extremely erosion-prone coastal plain soils in this part of southern Alabama. Sandy red, lacking in water-absorbing humus, the land gullies quickly when heavy spring rains hit recently plowed and planted fields. The topography is relatively steep, and slopes of 4 to 10 percent are routinely row-cropped. Moreover, the pig farms, though none of them are large, are also subject to washout rains, which deliver animal wastes in great quantities into the streams and thence into Lake Tholocco. What made this situation so difficult to deal with in terms of installing the management practices needed to reduce agricultural pollution in the lake was that the farms here are small, averaging but 80 acres, and the farmers poor, operating at or near subsistence level. Even though the program paid for 75 percent of the cost of the management practices required (to a limit of $50,000 per participant), the 25 percent remaining was hard to come by for most of the farmers.

The practices called for were lagoons and other devices to capture the animal waste runoff from the swine operations near streams. For the cropland, a variety of remedies were introduced to reduce erosion. Other practices involved repairing gullies and constructing terraces. Some of the land was retired from row-crop agriculture altogether under the Conservation Reserve Program of the 1985 Food Security Act, which compensates farmers for agreeing to take highly erodible land out of production for 10 years. Remarkably, almost all farmers were willing to cooperate with the RCWP; and in the end, approximately 80 percent of the critical areas in the watershed had best-management-practice contracts in place.

During the early years of the project, monitoring data on fecal coliform bacteria was a bit sketchy because samples were not taken regularly from the lake. Nevertheless, according to project officials, the bacteria count has "decreased significantly" since the beginning of the project. Officials also believe that the practices will greatly reduce sedimentation, although to what degree is uncertain because nitrate and turbidity studies did not begin until 1986.

There have been important ancillary effects of the project as well. EPA and the State of Alabama have developed a program to treat the critical areas of the watershed that lie within the city limits of Ozark, Alabama, including a $2 million project to construct new lift stations and sewer lines. At Fort Rucker, officials

This gully between two row-cropped fields contributed its share of sediment to Alabama's Lake Tholocco.

The best management practices included installing an underground pipe that carries runoff water to a stilling basin, which slows the water to a nonerosive velocity.

have addressed several critically eroding areas through roadway improvement, tree planting, and the like, with RCWP project people operating as consultants. Best of all, Lake Tholocco has not been closed a single day since this rural clean water project began. In 1988, the lake manager, an officer from Fort Rucker, reported that the water was cleaner than ever.

Delaware:
The Appoquinimink River Watershed

For most of its short length, the Appoquinimink River is a broad tidal creek, running from Delaware Bay to Odessa, Delaware. The watershed itself extends further inland to the city of Middletown. Throughout, the Appoquinimink is rich in wildlife and, along with several large ponds associated with the river, is a popular sport fishery.

The ponds are ringed by houses whose residents began with increasing frequency during the 1970's to complain of algal growth and of dead fish in the pond reeds and around the docks. They believed that runoff from nearby cropland was the problem, for scientists at the University of Delaware had discovered atrazine, a herbicide, in the water. In addition, nitrates and phosphorus from chemical fertilizers were causing eutrophication.

Despite the fact that increasing amounts of land in the watershed were being developed for residential use, which has its own nonpoint pollution effects; and despite the fact that there were several potential industrial polluters, including a plastics factory and a battery factory, local agricultural officials felt that a significant effort should be made to reduce agriculture's own contribution to the problem.

The management practice emphasized was the conversion of row crop cultivation to no-till. Under the project, no-till acreage was increased from about 50 percent of the cropland to the current 90 percent. In addition, farmers reduced pesticide use, planted cover crops in the fall to reduce winter runoff, and installed grassed waterways, filter strips, and other facilities. Participation resulted in 85 percent of the critical land in the watershed being under some kind of best management practice.

Almost all the work has been completed in the watershed, and the results are impressive. Erosion has been reduced by 7 tons per acre per year, which along with improved fertilizer and pesticide management techniques has lowered the level of suspended solids in the river by 60 percent. In one of the ponds, monitoring results show that sediment levels have declined by 90 percent and total phosphorus by 65 percent.

The benefits of the project have spilled over into other parts of New Castle County as well, in that most farmers in the county have voluntarily adopted no-till as their primary tillage practice.

This waterway in Delaware was smoothed and stone was placed over it to reduce erosion and runoff.

Florida:
The Taylor Creek-Nubbin Slough Watershed

This watershed drains into the ecologically fragile Lake Okeechobee, second largest lake in the United States excluding the Great Lakes, a water source for south Florida and essential for maintaining the water flows through the Everglades. Okeechobee provides, moreover, an important recreational and commercial fishery.

Though contributing only 4 percent of the total inflow to the lake, the watershed project area nevertheless contributes nearly 30 percent of the total phosphorus loading. An excess of phosphorus can lead to disastrous "hypereutrophication" affecting the manifold economic and ecological benefits the lake provides. An indicator of eutrophication status is the apple snail, principal diet for the Everglades kite, an endangered species. When heavy algae blooms appear, the snail disappears and so does the kite.

The source of this pollution is an extremely concentrated dairy industry that during the 1960's moved inland from Miami and other rapidly growing coastal cities to establish new, large-scale dairies on the cheaper land around the north end of Lake Okeechobee, an area that already had a number of cattle ranches. The dairy herd overall is approximately 25,000 head, with an equal

Shades were provided to protect dairy cattle from Florida's hot sun after streams were fenced to keep animal wastes away from waterways.

number of beef cattle. Principal management practices under the RCWP have included fine-tuning existing waste management systems, such as recycling the water used to wash down barns and other places where manure accumulates. In some cases, irrigation systems were added to use dairy wastewater. In addition, streams were fenced off to keep livestock from lounging in the streams during hot weather. Portable cattle shades were provided instead, which keep the livestock cool and the animal wastes away from the waterways.

Farmer participation is nearly 100 percent. According to local officials, phosphorus levels in lake water, as measured at the point of entry from the watershed, have declined since the beginning of the project from 1 part per million to 0.55 part per million, a reduction of 45 percent. Statistically, scientists of the South Florida Water Management District, which handles the monitoring, have assigned a 67 percent confidence level to this finding, which is more conservative than some project officials believe is called for.

Based on the operational success of the project, the State of Florida has established a similar effort in a large, adjoining watershed, the Kissimmee River, in which the RCWP has a minor administrative role, though serving as a model. The purpose of the Kissimmee project is to assess how Florida dairies can meet the State's new "dairy rule," which requires "mass nutrient balance" for every farm. All nutrients created by a dairy must be retained on the land owned by the dairy, rather than exported in waterways. Any excess may lead to an enforced reduction in herd size. In addition, milking herds are congregated so that the runoff of wastes can be captured more efficiently, with sophisticated drainage and recycling systems installed so that the land can take up the maximum amount of phosphorus from manure spreading and wastewater irrigation.

Idaho:
The Rock Creek Watershed

Idaho boasts some of the greatest trout streams in America and one of the great western rivers, the Snake, which meanders from the Rockies to join the Columbia on its way to the Pacific. One of the trout streams, Rock Creek, runs northward through irrigated farmland, into and out of the city of Twin Falls, and joins the Snake after a journey of 40 miles. Until recently, there were no wild trout in this trout stream. The water, carrying silt washed from the irrigated farm furrows upstream, looked like "cocoa-mud," in the phrase of one local official. Trout can neither live in mud nor spawn when the clean gravel they need is covered with silt. The agricultural nonpoint pollution, together with municipal and industrial wastes, made Rock Creek notorious as one of the most severely degraded waterways in Idaho. In 1971, it was listed in the "Wildlife Habitat Obituary" of the *Idaho Wildlife Review,* a publication of the State's Department of Fish and Game.

The agricultural part of this problem, which had the greatest effect on trout population and which made the creek so ugly to tourists and to the citizens of Twin Falls, arose because of the cost of irrigation water (cheap) and the nature of its delivery onto the land (bare-earth furrows). Since it cost but $14 per acre per year to irrigate land from water supplied to farms through common irrigation district ditches, farmers used plenty of it. As it coursed down the furrows, set 2 or 2½ feet apart and plowed anew each year, it picked up the fine silt particles of the loessal soil so that extremely turbid water flowed back into the creek through the irrigation district's return flows.

The management practices installed, covering some 75 percent of

Fine, silty loess particles loaded Rock Creek with sediment in this 1979 photo taken at the mouth of the stream.

By 1986, the sediment load had been reduced by an average of 70 percent, and trout once again were able to spawn in Rock Creek.

the critical area cropland in the watershed, were designed to reduce the erosion caused by high velocity water running down long furrows. These have included use of gated pipes in the field instead of ditches and siphon tubes to get the water into the furrows. Each pipe section has closable perforations that can be individually manipulated, reducing velocity and delivering water selectively down a furrow rather than indiscriminately. Less expensive remedies are filter strips and sediment ponds installed at the lower ends of fields to permit some of the silt to settle out before being returned to the creek. The unlined delivery ditches were replaced by concrete channels, and some return flows were piped back into the creek rather than sent through earthen canals.

The effectiveness of most of these practices has been excellent. Field studies indicate average sediment load reductions of 70 percent, as well as similar declines in phosphorus and other chemicals carried off the field with the silt. The difficulty is the high cost of the new irrigation equipment and structures. For this reason, project officials are now pushing hard to get conservation tillage adopted in the watershed. This could dramatically reduce erosion and thus sediment, as well as the farmer's costs because conservation tillage, especially no-till, requires fewer machine- and man-hours on the field. The effort has met with limited success so far — about 10 percent adoption — owing to the types of crops raised, some of which are not amenable to conservation tillage (primarily sugar beets), and to farmer resistance to adopting difficult new methods. There is some public resistance to no-till as well because of increased herbicide use. However, were the cost of water higher in the watershed, farmers likely would convert to conservation tillage more readily because it conserves soil moisture as well as soil.

In any event, the trout are back. A stable wild trout population is now able to spawn in the clear gravel margins of Rock Creek.

Illinois:
The Highland Silver Lake Watershed

The 600-acre Silver Lake is the source of drinking water for the city of Highland, Illinois, a rapidly developing community within the metropolitan area boundaries of St. Louis. The lake itself, a long, narrow impoundment, lies on either side of Interstate 70, which delivers commuters to the city and surrounding employment centers in its immediate suburbs, a half-hour's drive away.

Despite increasing suburbanization, the watershed of the lake has remained in cash-grain farming — corn, soybeans, and wheat. And the farms along Little Silver Creek and other tributaries, about 100 of them, have been steadily sending sediment downstream into the lake. In the late 1970's, the lake became so polluted from the combination of suburban development and agriculture that large amounts of chlorine had to be used at Highland's water treatment plant, making the water almost undrinkable for many residents. Moreover, the turbidity was such that fishing had declined substantially.

This was not the ordinary problem of suspended solids, however, for some soils in the Silver Lake watershed have a high sodium content. The erosion of these "natric" soils releases fine, charged soil particles that settle very slowly and are easily stirred up. Accordingly, in Silver Lake, visibility through the water was rarely better than 2 feet and usually much less.

To correct this condition, management practices installed under the RCWP included conservation tillage, along with diversions, grassed waterways, and terracing to control agricultural runoff. By far, the most important of these practices was conservation tillage, which had not been used previously to any great extent in the watershed.

Virtually all of the critical-area acreage came under some sort of RCWP plan, with the result that water quality in Silver Lake has improved. Although the monitoring program has not yet demonstrated water quality improvements resulting from practices installed, Highland residents have noticed an improvement in the chlorine taste of drinking water, and fishing in the lake is a great deal better. According to Highland's city manager, turbidity declined in 1986, when measurements showed that "NTU's" (nephalometric turbidity units) had been reduced 14 percent — from 74 NTU's, the level reached in 1984 and 1985, to 64 NTU's in 1986. This meant a sizable reduction in water purification costs for the city, a savings that project officials believe will continue.

The effectiveness of the project has also resulted in greater interest in conservation tillage in other watersheds in southern Illinois. Under a State-funded program, smaller-scale projects are being mounted elsewhere with the guidance of soil conservation districts. Even a nongovernmental spinoff has taken place in which a commercial recreational developer on a nearby lake has created a conservation tillage information program to encourage nearby farmers to use this practice. The developer expects that he can substantially reduce his dredging costs this way.

Iowa:
The Prairie Rose Lake Watershed

In Arkansas, say, or New York State, a 220-acre impoundment serving as a recreational lake would be nothing special. But not in western Iowa. Here, in a pocket of Iowa's rolling agricultural landscape that is mostly corn but also soybeans, small grains, and hay, Prairie Rose Lake is a major attraction, not only in its own Shelby County, but as far away as Council Bluffs and Omaha, Nebraska. The lake is filled with bass, bluegills, and bullheads; the surrounding 600-acre State park has more than a hundred campsites for tents and trailers; and there are swimming and boating and picnicking, too. In all, a quarter of a million visits are made to Prairie Rose each year.

The rolling landscape, which creates such a beautiful setting for Prairie Rose Lake, looked for awhile as if it might be the lake's undoing. The soil is deep loess, from a German word meaning "loose." So loose is it in fact that the erosion rate for the area as a whole was 20 tons of topsoil per acre per year. In the steeper sections, which comprise two-thirds of the watershed, with slopes up to 18 percent, erosion was reaching 30 tons per acre per year, 500 percent greater than the 5-ton limit set by USDA as a tolerable maximum. As a consequence, the lake turned an ugly, muddy brown; large parts of it were filled with sediment; and the runoff brought undissolved agricultural chemicals with it. Fewer anglers came from Omaha, swimming was discouraged, and the campsites went unfilled.

Although in many areas of Iowa conservation tillage has served to reduce erosion by a significant amount, the slopes in Shelby Country are so steep that this relatively low-cost remedy could not, by itself, stem the run-

Stripcropping, in which crops are planted in alternate bands, can reduce erosion by up to 50 percent. Soybeans and hay are alternated in this Iowa field.

off from many fields. Accordingly, the management practices designed for the farmers in the Prairie Rose watershed relied heavily on terracing, of which 75 linear miles were constructed, and underground drains to lead water safely off the fields. The terraces, in combination with reduced tillage (disking, usually, which was not ordinarily cost-shared under RCWP), plus some conservation tillage (no-till), seemed to do the trick. Eighty percent of the watershed's land was so treated, and erosion was reduced to 5 tons per acre per year. In the lake, sedimentation was reduced by two-thirds, according to project officials.

At the outset of the RCWP project, State officials had drained the lake to get rid of trash fish (carp) that had invaded it, and dredged it where necessary. When the lake refilled, it was a brilliant blue; and now, thanks to RCWP, so it is expected to remain, even though from time to time a natural algae bloom might occur—the tradeoff with turbidity, for algal growth cannot occur in muddy water. No matter. The anglers are back, the swimming beach well-used, and the campsites filled again at Prairie Rose.

Louisiana:
The Bayou Bonne Idee Watershed

A "bayou," smaller than a river but bigger than a creek, is a sluggish, often meandering waterway. This one, Bonne Idee (pronounced Bonnadee), runs through the heart of Morehouse Parish (county) in northern Louisiana, a rural area just south of the Arkansas State line. Along the bayou, there are ducks for the hunter; and deer and small game live in adjacent bottomland hardwoods. The bayou itself is deep and wide, up to 200 feet wide in places, and home to lunker bass, bream, and white perch. The surrounding land is planted mainly in cotton.

In the 1970's, the accumulation of pesticides sprayed on the cotton over the years, principally toxaphene and DDT, had risen to such levels in fish taken from the bayou that, on a "whole-fish" basis, tissue analysis showed toxicity levels above those permitted by the Louisiana Department of Environmental Quality. For the edible parts of the fish, toxicity levels were, at best, "borderline" in terms of human consumption.

Although DDT and toxaphene are among the pesticides now banned by Federal law, they are extremely persistent in the environment. High levels remain not only in the sediments of the bayou but in the soils of the cotton fields. The management practices required by the RCWP, therefore, were those that would reduce silt load in runoff. Prescribed were land-leveling to flatten out the gently rolling cotton land, planting cover crops to retard runoff from the heavy fall and winter rains, and establishing permanent grassed areas to reduce erosion.

Unfortunately, the project was plagued with administrative problems stemming from the reduction of its operating area from more than 200,000 acres to 60,000 acres. Moreover, the costs to farmers for land-leveling was too high for many during a period of great price instability for cotton. According to project officials, only a 50-percent Federal cost-share could be provided at the outset, significantly lower than the allowable 75 percent maximum. Then, a year or so later, after the reduction in the size of the project area, the cost-share was further reduced to 30 percent for land smoothing, leveling, and water conveyance. As a result, only about 50 percent of the critical land in the watershed is now covered by RCWP-prescribed management practices.

Despite these problems, officials believe the Bonne Idee project has helped encourage farmers throughout the area to limit the use of pesticides and to leave grassed areas in their fields to reduce the silt load in runoff. Data from monitoring is still sketchy and inconclusive, but the Louisiana Department of Environmental Quality has found a much reduced level of pesticides in fish tissues and, according to project officials, department scientists no longer consider the bayou to be a problem in this regard.

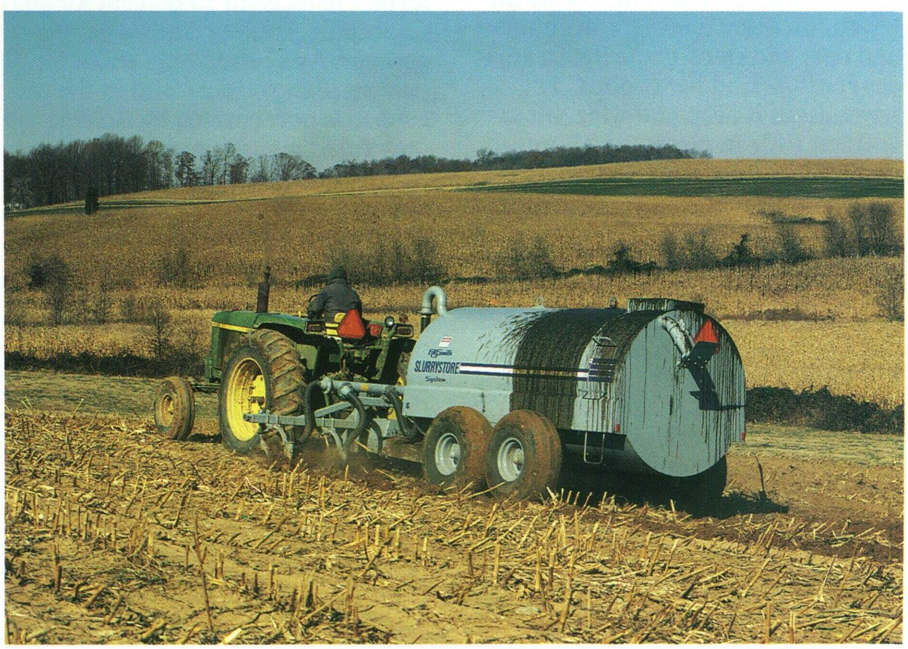
Maryland:
The Double Pipe Creek Watershed

The Double Pipe Creek watershed is part of a larger drainage system that flows, via the Monocacy River, into the Potomac River above Washington, D.C., and thence into Chesapeake Bay, for which the water quality of all tributaries, even distant ones, is consequential. Carroll County, where the watershed is located, is the largest dairying county in Maryland; and within the county the watershed has the greatest concentration of dairy farms. As a consequence, excessive quantities of fecal coliform bacteria have been moving into the creek and, ultimately, into the Chesapeake.

The management practices developed for the watershed's farms by local RCWP officials have focused on animal waste control systems. These have included lagoons, manure storage pits, drainage systems, vegetative filter strips along waterways, and the like. Most recently, practices involving fertilizer and pesticide management have been developed on farms in the watershed.

About 80 percent of the critical area in the watershed is covered by RCWP management plans, which are approximately 75 percent installed. The effect of this work, while apparent to farmers and project officials who are aware of the vast reduction in animal wastes reaching the waterways, is largely unmonitored and, therefore, statistically unverifiable. The State of Maryland, which has handled the monitoring, did not coordinate its work well with project planning and hence could not produce reliable results. A new monitoring scheme was devised in 1987, but statistics are not expected to be available for 3 years or so.

Farmer cooperation has been better here than in most other RCWP areas, and the project's effectiveness in encouraging pollution-abating management practices throughout the Chesapeake drainage has been enviable. On that basis, despite the paucity of monitoring data, the project has been judged a success. In July 1988, a field day for farmers, governmental officials, and environmental groups throughout Maryland attracted several hundred participants.



In Maryland, manure injection allows nutrients to stay in the soil rather than running into streams, even in wet or freezing weather.

Massachusetts:
The Westport River Watershed

The Westport River is, for the most part, an estuary at the mouth of Buzzard's Bay, south of Cape Cod, and opposite the Elizabeth Islands, themselves opposite Martha's Vineyard. These are prime yachting waters and historically prime shellfish waters, too. However, because of high levels of fecal coliform bacteria, the shellfish beds have often had to be closed, some permanently. Shellfishing is not merely recreation here. When the beds are open, the scallop harvest can total nearly $3 million, as it did in 1985, an exceptionally good year.

The bacteria have many sources, including seepage from residential septic tanks. However, a prime cause presumably has been the dairy farms along the upper reaches of the river. It is in the upper river that the shellfish beds historically have been all but permanently closed; in the lower reaches the beds are often open, depending upon the amount of rainfall. The management practices called for by the RCWP, as in the case of other project areas with this kind of problem, are comprehensive animal waste management systems, including manure pits, lagoons, diversions, guttering, filter strips, and carefully worked out fertilizer management plans to help farmers keep the wastes on the land, where it can improve pastures rather than pollute the water.

Although the offer to share the cost of such practices has resulted in relatively high levels of farmer cooperation elsewhere, in the Westport River watershed the adoption of improved practices has been low. One reason given by project officials was a high turnover of technical personnel in the local SCS office. The project's coordinating committee now believes it might have been better if private engineers had been hired by farmers

to do the design work for the management practices recommended. Of the dairies in the critical area, only half have cooperated. Implemented practices cover less than a quarter of the critical upstream acres in the watershed. This is not expected to have a substantial effect on the closure of the shellfish beds.

Manure lagoons are only one element of an elaborate storage and disposal system to keep nutrients on the land and out of the waterways.

Michigan:
The Saline Valley Watershed

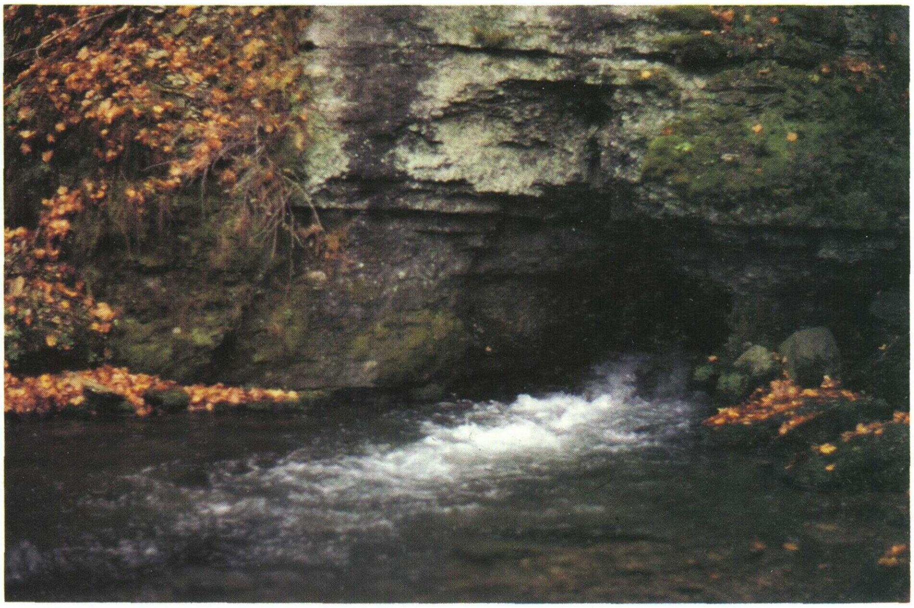
In 1972, the United States entered into an agreement with Canada, under the auspices of the International Joint Commission, to reduce the nonpoint source nutrient loading in the Great Lakes. Phosphorus, which had already turned a large part of Lake Erie algae-green and commanded media attention coast to coast, was to be reduced by 30 percent.

One of the contributors of nonpoint phosphorus was the agricultural area of the Saline River valley in southern Michigan. It was a minor contributor to be sure, but that exemplifies the problem with nonpoint source pollution: the diffusion of sources does not lessen its effect. The Saline Valley, just south of Ann Arbor and not far from Detroit, is intensively farmed. About two-thirds of the valley is cash-grain cropland and one-third is in livestock farming, including sheep. In fact, Washtenaw County, where the Saline rises, has more sheep than any other county east of the Mississippi River. All the farmland, whether cash-grain cropland or dairy or sheep pasture, was contributing phosphorus via the Saline River (and the tributary Macon Creek) to Lake Erie. The aim of the project was to conform with the International Joint Commission agreement and reduce the watershed's nonpoint pollution contribution to Lake Erie by 30 percent.

Wastes from dairy cows such as these were contributing excessive nutrients, particularly phosphorus, to Michigan's Saline River and thence to Lake Erie.

The management practices called for included comprehensive animal waste management systems, the most expensive item and the most crucial. Dairy wastes were a primary source of the total phosphorus load, and such systems were needed to cope with them here, as in other projects. According to one project official, of the 27 systems installed, which cost between $35,000 and $150,000 apiece, only 4 or 5 might have been installed without the RCWP cost-share allowance. On the cropland, the major management practice the project encouraged was conservation tillage. As for the sheep, they do not contribute greatly to the pollution load but, like the dairy herds, were fenced away from the streams.

Actual participation in the project was low compared with some of the other projects. Only about a third of the farms were enrolled, with overall coverage of about 45 percent of the land in the critical area of the watershed. Monitoring results are inconclusive, but University of Michigan scientists estimate that, based on current animal waste treatment activities, the watershed may have already met the 30-percent reduction goal for phosphorus. It is not likely that the watershed will further reduce phosphorus pollution, however, because most of the work on the practices installed has taken place, and there is no money left for new cost-share contracts.



Southeast Minnesota is underlain with limestone bedrock. The bedrock is easily dissolved by water, leaving solution cavities, caves, and caverns.

Minnesota:
The Garvin Brook Watershed

The term "karst" derives from Corso, a town in Yugoslavia along the Dalmation coast of the Adriatic. Here, as in some other parts of the world, including the United States, a massive stratum of soluble limestone (calcium carbonate) just beneath the surface of the soil has become so fissured and hollowed out by the slightly acidic ground water that streams just disappear underground, only to reappear later as springs and then disappear again. Limestone caves are formed in such areas, and as the caves grow higher and higher toward the surface, the roofs give way and "sinkholes" result. These are funnel-like structures that send the water collected in them back to the underground system. Indeed, the water systems above and below the ground are so interchangeable in a karst region that there is little practical difference between ground water and surface water. If one is polluted, so is the other.

In the United States, isolated karst regions can be found in many places, with quite sizable ones in north central Florida; in the area where Illinois, Indiana, and Kentucky meet; and along the Upper Mississippi in southeastern Minnesota and adjoining parts of Wisconsin and Iowa. It is in the Minnesota part of this latter karst region that a distinguished trout stream named Garvin Brook is located. Comprised primarily of dairy farms, the brook's watershed also includes a significant amount of cropland planted in corn for silage.

When the Rural Clean Water Program started here, considerable emphasis was given to Garvin Brook's quality as a fishery. Runoff from the dairies was polluting the water with fecal coliform bacteria, and sediment from the row-cropped land was covering the gravel bottoms needed for spawning. The management practices prescribed for such cases are comprehensive animal waste management systems for the dairies, including waste storage structures, liquid waste ponds, and the like, and reduced tillage for the cropland to keep crop residues at or near the surface in order to impede runoff.

Although ground water pollution was recognized at the outset of the Garvin Brook project, it was not until 1985 that this problem was identified as requiring a focus all its own, rather than as an element in an overall program to reduce pollution in the brook. Because of the karst geology, chemicals from the commercial fertilizers and herbicides used on the cropland were being delivered almost directly into the watershed's ground water. In some areas, nitrates in well water often exceeded 10 parts per million, the widely-accepted threshold concentration established by public health officials. When this standard is exceeded, people are warned not to

Sinkholes dot the landscape in the Karst region. They form where the shallow soils over the fractured bedrock collapse into the cavity formed by ground water. Sinkholes provide a direct avenue for contamination of ground water.

drink the water, and infants are considered especially at risk. Herbicides, especially atrazine and alachlor, also were showing up in well water in concentrations high enough to cause State health authorities to issue warnings to those residents who relied on shallow wells for drinking water.

Accordingly, a new management approach was developed to deal with ground water pollution. Rather than specializing in animal waste management structures, the project began to emphasize ways to reduce the amounts of fertilizers and pesticides used by farmers in the watershed. Careful management systems were developed, including a reduction in pesticide use for corn rootworm.

Sinkholes were a special problem. The funnel-like shape of these formations provides a direct route for polluted surface water to enter the ground water (which may later emerge through springs as surface water again). To cure this problem completely, an elaborate geological repair project is required. Surface soil in the sinkholes is bulldozed out, the limestone fissures are filled with a concrete grout, and the hole is filled to the surface with alternating layers of plastic sheeting and soil. The cost can be as much as $10,000 to treat one sizable sinkhole. A cheaper method is to leave the sinkhole alone and build a berm or dike around it to keep water from flowing into it.

Because of the new emphasis on ground water in the watershed, the critical area had to be redefined. Because well water monitoring data have been collected for the redrawn critical area only since 1986, no reliable findings have emerged to judge the effects of the sinkhole work or the improved fertilizer and pesticide use systems. Project officials have most recently emphasized fertilizer and pesticide management as opposed to sinkhole filling, thinking that these practices may have a greater effect on ground water quality and are a great deal more economical.

Nebraska:
Long Pine Creek Watershed

Long Pine Creek is one of Nebraska's treasures. A cold, clear stream set amid steep, wooded terrain that provides relief from the sandhill area that surrounds it, the creek is the longest self-sustaining trout stream in the State. With its tributaries in the watershed, it creates a topography of rare natural beauty and recreational importance.

There are many sources of pollution in the watershed other than agriculture: a municipal sewage treatment plant and overflowing septic systems, for instance, and several large feedlots that State authorities have designated as "point" sources of

Sandy banks and excessive runoff combined to make Nebraska's Long Pine Creek turbid and over-enriched with nutrients.

Planting vegetation along the areas of high stream velocity reduced streambank scouring and filtered out sediment from water entering the stream.

pollution rather than nonpoint and that, consequently, are beyond the reach of RCWP.

With the advent of irrigation, the area changed from cattle ranching to intense row crop agriculture. In fact, the watershed is now so heavily irrigated that its basic hydrologic dynamics have been permanently altered. In some areas, the water table has been raised to such an extent that seasonally dry tributaries now run full year around. Banks erode; bottom sediment is stirred up; streams cut deeper and deeper into the creekbeds. Combined with the runoff from cropland on which large amounts of fertilizer and pesticides are applied, the result is turbidity and an excess of agricultural chemicals in the clear waters of Long Pine Creek.

The irrigation water originates either from private wells or from the cooperative Ainsworth Irrigation District, which provides water via a canal and laterals to some 244 farms, irrigating more than 34,000 acres in the watershed. A feature of the irrigation district is that farms must continue receiving water from it, whether or not the water is needed. Accordingly, after a storm, irrigation water simply winds up as runoff, adding to the nonpoint problem because there is no practical way of disposing of it.

Given the basic change in the hydrological system throughout the watershed, and given the way the irrigation district delivers its product, management practices had to be planned on an areawide basis, and specialized approaches had to be considered. One of these, and the most costly, was the construction of a secondary waste disposal facility that the irrigation district could use in the case of a storm. The facility was designed to store unneeded water so that it could later be redelivered into the canal.

Other management practices included tailwater recovery systems for individual farms in which excavated pits would store water that could then be pumped back onto the fields. Diversion systems were also installed that would direct waste irrigation water and stormwater away from erosion-prone areas. Efforts to reduce bank erosion ranged, on the most elementary level, from controlling the advancement of gullies into the fields to fencing cattle away from streambanks. A more sophisticated approach was using cedar logs in fast-running tributaries as a kind of revetment along the channels, creating a secondary bank that would move the channel away from high (sometimes 20 feet) cut banks that might otherwise collapse and cause major episodes of turbidity.

Some 78 percent of the critical area in the watershed now has management practices such as these in place, along with more traditional techniques, such as conservation tillage to reduce runoff, and integrated fertilizer and pesticide management systems to lower the overall amounts of agricultural chemicals. Baseline monitoring of streamwater has been completed, with follow-up monitoring planned for 1990 or 1991, after the new structures and other techniques have had time to work. Already, however, project officials report a noticeable difference in the water quality. And in the fields, pheasants, which have been scarce for 10 years or more, are coming back now that pesticide use has been reduced.

Oregon:
The Tillamook Bay Watershed

Five rivers, tumbling out of the Pacific Coast Range, run into Tillamook Bay, a top recreational shellfishing area and the location of two commercial oystering operations. The rivers are themselves filled with Chinook and steelhead salmon, making the area Oregon's finest sport fishery. Up the river valleys, which are foreshortened by the steep mountains, lie the lush pastures of the Tillamook dairy farmers. For nearly a century, these farmers have provided the milk for Oregon's world-class Tillamook cheddar, produced in increasing quantities by the Tillamook County Creamery Association, which is cooperatively owned by the dairy farmers.

All went well until the late 1970's, when the Food and Drug Administration threatened to close the bay to interstate commerce in shellfishing unless something was done to reduce the level of fecal coliform bacteria that had been steadily rising in bay waters. Not only would this mean the end of the oystering, but it would also cut into recreational shellfishing and reduce tourism, including the many visitors to the cheese factory.

The problem was some 300,000 tons of manure each year produced by the dairy farms, about a hundred of them, in the watershed. None was more than a few miles from the bay, and some were located on bay tidelands. The lifespan of fecal bacteria is not long, but it is long enough so that the bacteria would remain at high levels when runoff from the dairies reached the bay. Almost everyone understood the possible effects on the interlocking economy of the area. For the creamery association, the connection between a clean environment, clean dairying, a clean public image, and cheese sales was as obvious as it was crucial. Moreover, Oregon is tough on polluters, levying steep civil penalties and providing no

exemption for agriculture. Accordingly, most dairy producers welcomed RCWP. For the others, the creamery ruled that any dairy falling below the highest standards of cleanliness, based on an inspection by creamery officials, would have to participate in the program or receive a lower price for its milk.

Oyster harvesting in Tillamook Bay is again safe.

The practices installed to reduce the runoff of animal wastes from the dairies into the rivers and eventually the bay have included, notably, the construction of sheds to provide manure storage sheltered from rain and elaborate drainage systems—guttering, curbing, piping—to divert uncontaminated rainwater that falls onto barns, sheds, and holding areas into the rivers rather than letting it mingle with the animal wastes. The key factor here is that it rains 100 inches a year. When the rain hits the manure, fecal bacteria are delivered directly to the bay. The new sheds can hold a 90-day accumulation of dry manure, and liquid wastes can be collected in concrete storage tanks. The accumulated material can then be spread on the pastures during drier times when the ground is able to absorb the applications.

A good deal of construction work still remains for the cost-shared projects. But even though half of the new management practices are yet to be installed, fecal bacteria counts have declined 20 to 80 percent in the bay and in rivers, depending upon the monitoring station, with a typical reduction in the 40- to 50-percent range. According to project officials, the dairies' contribution to the bacteria count have been reduced 60 to 70 percent. Moreover, farmers are noticing increases in salmon in the tributary creeks running through their pastures, a sure sign that the region's environmental quality is on the mend.

This below-ground liquid manure tank in Oregon stores wastes until they can be safely spread on dry land.

Pennsylvania:
The Conestoga Headwaters Watershed

This watershed has the highest nonpoint source pollution potential in Pennsylvania. It lies within the most intensively farmed county in this State, which is itself the most agricultural of all on the eastern seaboard. The Conestoga headwaters are located within the watershed of the Susquehanna River, which produces 50 percent of the fresh water flowing into Chesapeake Bay, which of all the major estuaries in the United States is the most seriously threatened by agricultural nonpoint source pollution. That is why the RCWP work in this watershed is so crucial.

The problem in Conestoga is manure. There is more manure per acre here than in most other places in Lancaster County, where most farms, including Amish and Mennonite ones, are small, intensive operations. The average farm size is about 50 acres. Animal density is 2.0 "animal units" (a unit equals 1,000 pounds of cow, calf, poultry, or swine) per acre. As a consequence, the nitrogen loading in the streams and in the ground water (for this is, in part, a karst area) is severe. Some of the farmers who routinely applied commercial fertilizer as well as manure were using more than 400 pounds of nitrogen per acre per year, twice what agronomists recommend. Not surprisingly, the nitrogen showed up in wells in the karst areas of the watershed, where the fissured limestone absorbs water rapidly. One monitoring well

Ground water monitoring in Pennsylvania. Karst geology in the Conestoga Headwaters area makes it easy for nutrients applied onto the land to enter ground water.

showed 53 parts per million of nitrate, and some of the 42 domestic wells and springs sampled in the area showed as high as 40 parts per million. Public health authorities recommend a maximum nitrate limit of 10 parts per million.

Although a wide range of management practices were undertaken to reduce the nutrient loading of the surface water and ground water in the watershed, by far the greatest emphasis in recent years has been placed on "nutrient management." The object is to reduce the amount of nitrogen imported to the watershed and to manage the manure and fertilizer that is used extremely carefully so that an excess is not transported to surface water or ground water. The techniques required to reduce overall nitrogen involve the timing and location of fertilizer and manure applications as well as the use of crop rotations that will take up the nutrients most efficiently. To this end, at Pennsylvania State University, agronomists and computer scientists have developed a computer program permitting detailed nutrient management plans to be made on a field-by-field basis.

Implementation of these plans does not necessarily involve a cost for the farmers, but instead can produce a projected savings averaging $20 per acre for the 86 farms participating so far. Overall nitrogen use has declined between 15 and 20 percent, and farmers are seeing better stands and better yields.

Because the watershed area has experienced a hundred years or more of intense application of nutrients on the fields, the soil is so loaded with nitrogen (and potassium and phosphorus as well) that the monitoring stations established expressly to measure the effects of nutrient management have not yet shown a predictable change in nitrogen levels. Officials expect that results which showed up slightly in 1988 will be more significant in 1990.

The Amish and Mennonite farmers have been reluctant to participate officially, as is their wont for any governmental program, but they took up the practices voluntarily so that today a great many farmers in the watershed have some sort of reduced nutrient program on their land. Moreover, the State of Pennsylvania, under its Chesapeake Bay clean-up program, has been promoting the RCWP's nutrient management techniques in 13 other watersheds that are part of the Susquehanna system. Project officials believe that their work will someday result in an overall reduction of agricultural pollution in the upper Chesapeake.

South Dakota:
The Oakwood Lakes-Poinsett Watershed

Although the Oakwood Lakes, Lake Poinsett, and Lake Albert are significant recreational resources in this lake-studded South Dakota watershed, it's what lies underneath them that counts. And that is the Big Sioux aquifer, a shallow water-bearing stratum that provides drinking water for 90 percent of the people in the eastern part of South Dakota, which includes Sioux Falls, the State's largest city.

Though the original focus of this project was on the recreational value of the lakes, it was later changed to include ground water, and with good reason. If anyone needed a reminder of how important it is to keep drinking water pure while supporting an agricultural industry dependent on chemicals, it was brought vividly to mind in 1986. It was then, in De Smet, one of the corn-and-soybean farm towns within the watershed, that the death of an infant from "blue baby" syndrome made national headlines. The disease, methemoglobinemia, is an oxygen deprivation disorder that was brought on by high levels of nitrates in the well water used for the baby's formula. While the tragedy involved quite special circumstances and doubtless overdramatized the ground water situation in eastern South Dakota, it certainly validated the importance of expanding the focus of the Oakwood Lakes-Poinsett project.

The management practices undertaken in the watershed were straightforward, mainly reduced tillage so that at least 30 percent of crop residue remained on the fields after cultivation and could retard runoff. More important, strict pesticide and fertilizer management systems were called for. This meant that herbicide and insecticide use could no longer be routine, but would have to be limited to situations where weeds

and insects really seemed to be getting out of hand. To check weed and insect populations, "scouts" were hired from the nearby State university to walk the fields and report back to the farmers and project officials about potential infestations. To aid in fertilizer reduction, the scouts took soil samples for analysis in the university laboratory to determine how much was really needed.

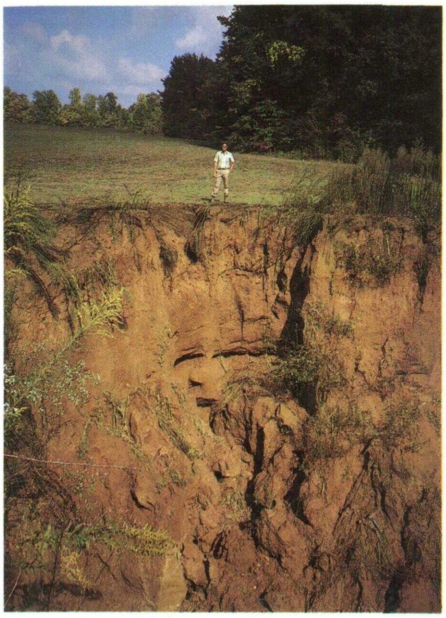
Monitoring of results has been extremely complex in this project. The variables are manifold and interact in unexpected ways: rainfall, water use, and aquifer levels all interrelate. Comprehensive ground water monitoring began in 1984, and results are not expected for several years. When they do come in, project officials believe that their implications for glacial till areas like the Oakwood Lakes-Poinsett watershed can be important ones from a public health standpoint—to ensure that the blue baby syndrome remains a rare malady, not only in South Dakota, but everywhere.

Sedimentation in Tennessee's Reelfoot Lake has made this pier a landmark to the effects of erosion.

Tennessee:
The Reelfoot Lake Watershed

In 1811, a mighty earthquake rent the Mississippi bottomlands, creating a fissure 18 miles long and 3 miles wide. Then, for the first and probably the last time in the history of the world, the great river ran backwards, filling up the gigantic crack in the earth. The result was Reelfoot Lake, now a State park, home of bald eagles, and a favorite destination for anglers who come from some distance to catch crappie, catfish, and bass.

The trouble with Reelfoot Lake began in the 1970's. These were good times for agriculture. Corn and soybean prices rocketed skyward, and farmers throughout the South converted their cow-calf pastures to cropland to cash in on the bonanza. Within the Reelfoot Lake watershed,[13] 25 percent of the land was converted from pasture to row-crop fields. In some places, converting to row crops was a good idea, but in the steeply sloping, loessal soils along the Mississippi River in the Reelfoot area, the new soybean fields produced turbidity levels in the creeks unrivaled since the earthquake. As a consequence, about 14,000 acres of the lake and 50 miles of the streams and tributaries were seriously affected by sediments and associated pollutants, particularly pesticides. Large fish kills became a frequent occurrence.



Highly erodible lands along the Mississippi River easily form gullies when row-cropped or when the trees have been killed by an infestation of kudzu. Treating these "bully holes" involves revegetating the area and reserving it as wildlife habitat.

The objective of the project was to try to convert as much land as possible back to pasture. Not only would the RCWP cost-share on the reseeding, but if farmers would sign a 10-year agreement to keep the land permanently in grass, a $70-per-acre bonus was given. After the decisive decline in commodity prices in the 1980's, a number of farmers agreed. Approximately 25 percent of the converted land has now been returned to pasture.

The monitoring has not yet produced reliable figures to show the degree of reduction in sediment and pesticides, but no fish kills have taken place since the program began, and siltation appears to have been checked.

Utah:
The Snake Creek Watershed

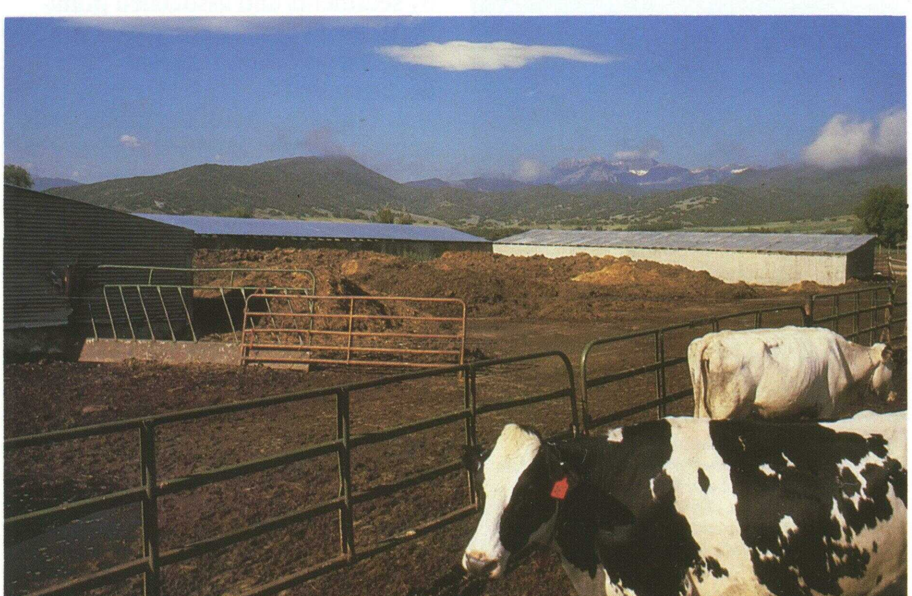
Six farms that together added up to less than 500 acres were a small part of the problem but a major part of the solution to the pollution of Deer Creek Reservoir, a popular recreational lake nestled in the mountains near Salt Lake City and Provo. The lake was becoming seriously eutrophic from an overdose of phosphorus.

The sources of phosphorus were several, including vacation and year-round homes and agricultural runoff from watersheds other than Snake Creek. In fact, the Snake Creek watershed contributed only about 10 percent to the total. Yet, it was urgent that everyone, even farms along Snake Creek, pitch in to reduce the amount reaching the lake by half, for the 7-mile-long Deer Creek Reservoir was not only a good place to sail and swim and fish, but it also served as a drinking water supply for growing Salt Lake County.

Of the six farms, four were dairies, one was a beef cattle ranch, and one was a mixed livestock (swine and beef cattle) operation. The management practices prescribed were comprehensive waste management systems, including concrete bunkers for manure storage, liquid waste ponds, piping and ditches to keep fresh water away from wastes in corrals and feeding areas, and fencing to keep livestock from lounging in streams. Of these practices, the most expensive and crucial were the manure storage facilities that permitted farmers to store manure and liquid wastes until spring instead of spreading them on frozen ground where they would run off directly into the waterways and ultimately into the reservoir.

Given such a small number of farms, the peer pressure for 100 percent participation was intense. And 100 percent is what the project got. As a result, according to officials in charge of monitoring for the project, phosphorus levels in the water leaving the watershed have been reduced by at least 75 percent. On one monitored dairy, the pre-project discharge amounted to 550 kilograms of total phosphorus per year into the stream. Following adoption of the prescribed practices, the level plummeted to a yearly average of 44 kilograms.

An equally important contribution of the project was the inspiration it provided government agencies to follow suit. EPA made a "clean lakes grant" to help reduce phosphorus in 19 other locations around the lake, and a State water district supplied supplementary grants to help farmers install best management practices. For its part, the county government (Wasatch) passed stiff regulations to limit phosphorus discharge from new land development. Today, throughout Utah, the project is seen as a model to protect valued water resources.



In Utah, manure bunkers are part of comprehensive waste management systems that reduce the quantity of agricultural wastes—and thus of phosphorus—that enters waterways.

Vermont:
The St. Albans Bay Watershed

St. Albans Bay, an arm of Lake Champlain, historically has been one of Vermont's most popular recreational areas, with St. Albans State Park attracting thousands of picnickers and campers each year. Then, during the 1960's and 1970's, park visitation began to decline. By 1978, use was only a tenth of what it had ordinarily been, and the park was closed. Elsewhere along the shoreline of the bay, vacation cottage properties were decidedly not holding their own in value. According to a study conducted in 1981, bayfront real estate had lost 20 percent in value when compared to properties elsewhere in the area. The effect on the tax rolls for that year was calculated to be approximately minus $2 million.[14]

The cause of the trouble was the increasing incidence of algal blooms and aquatic weed growth stemming from the overenrichment of the bay. Forty percent of the phosphorus, the most active enriching nutrient, came from two sewage treatment plants. But the other 60 percent originated from dairy farms in the bay's watershed area.

In Vermont, dairy wastes go directly into this storage tank, where they can be saved until the ground is able to absorb them.

Best management practices were installed under RCWP plans on 64 farms. The practices mainly involved improved animal waste management systems for manure and milk house wastes so that farmers would not have to spread manure on frozen fields during the winter months when it could not be absorbed. Without such systems, manure applied to fields in winter would simply run off at spring thaw, polluting the bay and doing little to enrich the pastures.

Farmer participation has been approximately 75 percent, which has led to a 47-percent reduction in the dairying contribution of phosphorus to the bay, based on estimates provided by sophisticated computer models specially created by the monitoring team from the University of Vermont. Residual nutrients remain in the bay ecosystem, however, and are the subject of a special study by university scientists. Specifically, there is a wetland at the head of the bay that for years, perhaps a century, has been a nutrient "sink" that under certain climatic and lake-level conditions can deliver high levels of phosphorus to the bay despite the dramatic reduction in pollutants.

The occasional algae-bloom effects of the "sink" notwithstanding, however, bayside real estate prices have already begun to improve, and a private concessioner has reopened part of the park.

Virginia:
The Nansemond-Chuckatuck Watershed

This watershed area, near Norfolk and Virginia Beach, is notable for two critical and extremely delicate water resource attributes. One is the shellfish beds of the Nansemond River and Chuckatuck Creek, both of which run into the James River, here part of the Chesapeake Bay estuary. The other is a series of 7 water supply lakes that provide drinking water to the nearly 1 million residents of this growing metropolitan area.

Upstream in the watershed as well as downstream along the estuaries, this is "hog lot" country, where swine are fattened for market. Many of these are small, open lots with no manure storage or waste treatment capability. They are a particular problem because they are frequently located on or near streams. Taken together, the hog lots in the watershed, with their 24,000 swine (plus 3,000 cattle, half a million chickens, and 125 dairy cows), were producing 87,000 tons of wet manure per year. On the small hog feedlots, the manure was not applied to fields but simply allowed to wash directly into the upstream creeks feeding the reservoirs and the downstream estuaries associated with the shellfish beds. As a consequence, the reservoirs were on the verge of becoming eutrophic from nutrients and were turbid from the sediments carried into them. In the estuaries below, 3,000 acres of shellfish beds had to be closed because of fecal coliform bacteria.

The principal management practices prescribed to deal with this

No-till soybeans near Norfolk, Virginia.

problem were hog lot waste management facilities, especially the construction of slats over pitted floors on the feeding areas, anaerobic lagoons, and various mechanisms needed to apply stored wastes to the fields. On the fields themselves, no-till was called for, along with filter strips and grassed waterways. To stop gullying, some 100 small earthen dams were built with drop-pipes for drainage.

All of the major livestock operations participated in the program, with best management practices applied to about two-thirds of the critical area in the watershed. Project officials believe that RCWP activities have taken care of about 75 percent of the nonpoint agricultural pollution, although water quality monitoring has not yet developed precise statistics. In general, however, the program is credited for the provisional reopening of shellfish beds, and the eutrophication threat seems to be receding in the reservoirs.

On this Wisconsin dairy farm, the wall in the background traps animal wastes so that manure solids can settle out and be removed manually. Rainwater and other liquids pass through small holes at the base of the wall and form a pond behind the 6-inch high gravel spreader terrace. Liquids work their way through the gravel and run into a grass filter strip for a final filtering.

Wisconsin:
The Lower Manitowoc River Watershed

Along the Wisconsin shore of Lake Michigan, there is a strip called the "nearshore waters." Two to six miles wide, these waters do not mix with the deeper, open waters of the lake, but remain as a "sink" for the sediments and pollutants that flow into them from the land. One of the rivers that delivers agricultural nonpoint pollution into the nearshore waters of Lake Michigan is the Lower Manitowoc. In the year prior to the RCWP project's start, some 41,400 cubic yards of material had to be dredged from the Manitowoc harbor.

Upstream, in the river's watershed, are some 333 small dairy farms that supply milk for the table and for Wisconsin cheese. The wastes from these farms pollute the nearshore waters, causing algal blooms and concentrations of fecal coliform bacteria that affect the quality of drinking water pumped from the lake for the city of Manitowoc. The aim of the project was to help the dairy farms reduce phosphorus loadings into the Great Lakes, of consequence not only to the city of Manitowoc, but mandated by an international agreement with Canada.

The management practices installed were mainly manure storage facilities — pits, lagoons, and other devices. At the start of the project, in 1980–81, farmers were especially interested in the program, for that was a good year for agriculture. However, the agricultural depression of 1983–87 caused many potential participants to withdraw in this watershed as in others of the program. At present, 57 percent of the critical area is under contract, and 31 percent of the practices have been implemented. Baseline monitoring was conducted by the State of Wisconsin, but no follow-up monitoring is planned. Nevertheless, considerably less sediment is going into the harbor. The average amount of material dredged since the project began is 25,000 cubic yards a year, 40 percent less than before.

Part III: Policy Options for the Future

As the preceding thumbnail sketches suggest, the effectiveness of these 20 projects is somewhat uneven, aside from whatever statistical findings are derived from final monitoring data. Not every story has a happy ending, but that is perhaps as it should be. There are lessons to be learned even in lack of success, for this has been an experimental program, an examination of techniques and processes on an operational scale. Given the wide range of situations encountered, including no small amount of bureaucratic confusion at the outset, it is surprising how few out-and-out failures there were.

Surmounting the Difficulties

Its beginnings, as recounted at the outset of this report, were anything but auspicious. The program as a whole was beset by management change, shifting objectives, poor reporting, and worse analysis.

These weaknesses were nobody's fault. This was an experimental program. Its focus was radically new—achieving water quality by changing the way farmers farmed. Traditional and non-traditional approaches were to be tried. Sometimes they succeeded, sometimes they did not. Moreover, the national coordinating committee was confusingly diverse—traditionalists, innovators, and those in between—and represented fields ranging from agronomy to environmental science to agricultural economics, as well as many approaches to conservation. Local officials who were to implement the program were never quite sure from month to month what their basic objectives actually were. Were the projects truly experimental, emphasizing sophisticated monitoring with paired comparisons? Were they pilot projects for a later program? Or one-time demonstration projects simply to get the nonpoint ball rolling? The answer was no help: they were all of the above.

But somehow, finally, everything got more or less sorted out. Then, the worst agricultural depression in 50 years struck at the heart of rural America.

Obviously, the problems at the top had to be reflected on the bottom. In one East Coast project, there was such a turnover in the local SCS office that 10 conservationists were, one after another, assigned to the project over an 8-year period. The result was that farmers, already suspicious of the program, simply ran out of patience, not to mention money. One irate landowner wrote that his participation in the program resulted only in "unnecessary costs, reduction of profitability, and general frustration."

In some projects, exceedingly expensive practices were put into place despite the fact that they could not conceivably be cost-effective when nonstructural remedies, such as conservation tillage and integrated fertilizer and pesticide management, could reduce pollution more and increase farm profitability.

On the monitoring front, in a small but significant fraction of the projects, the evaluative effort has been frustrating at best, hopeless at worst. In more than a few areas, no baseline data were collected at all. In others, a shift in project objectives caused scientists to give up in despair. In a few, the organizations charged with monitoring responsibility simply failed to do their part. In some cases, monitoring personnel have followed their own star, which has often proved irrelevant to the actual needs of the project. The upshot is that in many projects the effectiveness of the management practices installed may never be known.

Yet, most of the projects surmounted these built-in difficulties, if not immediately then eventually. Characteristically, the successful projects had strong, enthusiastic local leadership and a collegial approach so that project team members could work effectively and productively together. The members, from SCS, Extension, State agencies, and ASCS, held one another in mutual esteem in the best of the projects, and though they often disagreed, they did so without rancor. This enthusiasm and courtesy was transferred to farmers and others in the project area. Many lasting friendships were made because of RCWP, between and among Government employees, farmers, and local officials.

The successful teams were willing, even eager, to create original management plans for farmer-participants based on the particularities of each watershed and of each farm, rather than simply pulling practices "off the shelf." Sometimes, project officials had to travel to Washington to plead for rule changes. In more than one project area, ground-breaking agronomic research and analysis of broad national significance have been conducted in order to produce the most effective management plans for cooperating farmers.

As for monitoring, when the project evaluative system was well coordinated with field work, as it was in a good many projects, variations in results could be accounted for and tactical decisions on practices made, even strategic ones that could lead to adjustments in overall project design. Indeed, it would seem that, as a practical matter, usable monitoring results had as much to do with the integration of monitoring techniques with field operations as with the sophistication of the research approach.

As it turned out, a clear majority of the projects displayed successful characteristics, which is certainly a larger number than any of the originators of the experimental RCWP have a right to expect. How did it happen? As the foregoing discussion suggests, the identifiable difference between success and failure in these 20 projects was not the nature of the

nonpoint problem, or money, or locality, or local socioeconomic conditions. It was simply this: the more local project officials took control of their own work, the better the project turned out to be and the more useful the statistics (now and in the future) produced through monitoring. Such a finding may well suggest a future direction for the Rural Clean Water Program.

The Choices

There seem to be three choices generally under discussion by those concerned with RCWP. The first is to develop and fund a major national program based on the results of the 20 projects, a revisitation of the original RCWP concept authorized 10 years ago. The object would be to apply the techniques of the experimental program as soon as possible to the remaining watersheds in the Nation in which significant nonpoint source pollution from agriculture is present. Procedurally, this could take place under section 319 of the 1987 Clean Water Act, which, in effect, reauthorizes the original RCWP concept through State-level nonpoint source pollution programs. As mentioned previously, there are perhaps 600 agricultural watersheds needing the kind of attention given to the experimental 20. With the experience base so far accumulated, including many lessons about what not to do, the job can probably be accomplished for less, proportionately, than the average costs incurred in the experimental program.

A second choice would be to expand the experimental program on a flight-by-flight basis to the 600 watersheds over the next several years, with effective informational feedback so that lessons learned can be constantly refined and applied. This approach, which would intentionally replicate the experimental program, would consist of initiating groups of projects, say 20 or 30 at a time, in fairly rapid succession, but not all at once. This would presumably require an immediate authorization somewhat lower than that required by the first option.

A third choice would simply be to let the 20 projects conclude and adapt the lessons from them to the Agricultural Conservation Program (ACP) routinely administered by ASCS, under the 50-percent cost-share formula. Now that ASCS can offer a 10-year "long-term agreement," as much as $35,000 can be developed for the costly management practices sometimes required to reduce nonpoint source pollution. Possibly, an annual "rural clean water" component could be added to the ACP appropriation.

There are advantages and disadvantages to each of these approaches. For the section 319, "all-at-once" approach, the advantage is that nonpoint source pollution would be addressed forthrightly, comprehensively, and in a major and dramatic way, producing a significant political dynamic for pollution abatement on a State-by-State basis. Certainly, time is of the essence with respect to nonpoint source water pollution. However, money is a problem, as it was not in the 1970's. The national debt hovers menacingly over all congressional deliberations these days. Moreover, it is possible that a massive expansion would require so much administrative superstructure that it could vitiate the home-grown effectiveness of the best projects in the experimental program.

The flight-by-flight approach would, by replicating the experimental program, retain the maximum amount of local responsibility, which had so much to do with the success of many of the projects. The flights would not be so dramatic an effort as "all-at-once," and they could fail to produce the political momentum that was so much a part of the experimental program at the outset. Moreover, it might be difficult to coordinate such an effort as fully with the States' nonpoint source management programs. Nevertheless, the "roll-out" process could be expected to apply pollution-abating best management practices in critical watersheds on a planned basis, rather than haphazardly or not at all.

As for folding the experimental program into the ongoing ACP operation, which is continuously funded, this has a certain amount of administrative simplicity and budgetary appeal. Nothing new is really added, just a modicum of sustained effort. However, it would be difficult to develop the enthusiasm, focus, and sense of dedication that was so much a part of the experimental projects and perhaps crucial in terms of overall achievement.

There may, of course, be other approaches as well, along with an infinite number of choices concerning particular elements of a national expansion of the RCWP. For example, while the level of monitoring activity undertaken in the experimental projects would be neither necessary nor affordable on a national basis, it would no doubt be advisable to maintain a long-term commitment to monitoring work in a sample of the experimental projects. Monitoring would be most important in those projects concerned with evaluating the effectiveness of best management practices on ground water pollution, which today is a more compelling nonpoint source pollution issue than it was at the outset of the program.

Whatever direction policymakers take, the one imperative suggested by the experimental Rural Clean Water Program is that the work must continue. The economic and environmental problems created by agricultural nonpoint source pollution are major. To help policymakers deal confidently with these, the final

analyses of the monitoring data concerning technical remedies will be crucial in determining the relative effectiveness of the various agricultural management practices under study in a given setting.

At the same time, final monitoring results are not needed to confirm the potential importance of the program in terms of the larger issues raised by agricultural nonpoint source pollution. These include such matters as the continued viability of Chesapeake Bay and the water supply for a major part of a State, such as South Dakota, or a metropolitan area, such as Norfolk-Virginia Beach. They also include maintaining the balance of nature in the Okeechobee-Everglades ecosystem and meeting United States treaty obligations concerning Great Lakes pollution. These issues and the many others that RCWP have addressed are paramount, not merely in terms of agricultural economics, but the welfare of the Nation.

In this regard, the experimental Rural Clean Water Program, which has quietly gone about its business for the last decade, should now be recognized as a success story in itself and perhaps the beginning of a greater one. It would be tragic to ignore the story and doubly tragic not to realize its great promise, not just for clean water in 20 rural watersheds, but for the economic and environmental benefit of all America.

References and Notes

1. See, for example, Robert Rienow and Leona Trail Rienow, *Moment in the Sun* (New York: Dial Press, 1967).
2. 1977 National Water Quality Inventory, as quoted in John B. Braden and Donald L. Uchtmann, "Agricultural nonpoint pollution control: An assessment," in *Journal of Soil and Water Conservation,* January–February 1985. p. 23.
3. Office of Water, *National Water Quality Inventory: 1986 Report to Congress* (Washington, DC: U.S. Environmental Protection Agency, 1987). pp. 81–82.
4. As reported in Soil Conservation Service, *Environmental Impact Statement: Rural Clean Water Program* (Washington DC: Department of Agriculture, 1978). p. 12.
5. Carl F. Myers, et al, "Nonpoint Sources of Water Pollution," *Journal of Soil and Water Conservation,* January–February 1985. p. 17.
6. See Charles E. Little, *Green Fields Forever: The Conservation Tillage Revolution in America* (Covelo, CA: Island Press, 1987).
7. The brief description of some of the practices in these five areas is based on site visits and an examination of project reports. Additional information is available in Part II, which provides project-by-project descriptions. Detailed accounts of these particular projects will be published in a series of articles appearing in the *Journal of Soil and Water Conservation* during 1988 and 1989.
8. See Claudia Copeland and Jeffery A. Zinn, *Agricultural Nonpoint Pollution: A Federal Perspective* (Washington, DC: Congressional Research Service, Library of Congress, 1986), pp. 10–12. This paper provides an excellent roundup and analysis of nonpoint legislation.
9. According to author Neil Sampson, "The dual — and often conflicting — programs of the SCS and ASCS have been the source of a great deal of friction over the years. Every Secretary of Agriculture from Henry Wallace [onward], has been concerned with, but failed to find a solution for, the battling within USDA over the nature of the soil conservation effort." *Farmland or Wasteland: A Time to Choose* (Emmaus, PA: Rodale Press, 1981). p. 264.
10. *1980 Rural Clean Water Program,* Federal Register, March 4, 1980 (45 F.R. 14006), as reprinted by USDA Agricultural Stabilization and Conservation Service. p. 1.
11. Estimate provided by Walter Rittall, who represents SCS on the National Coordinating Committee's technical working group.
12. Unless otherwise noted, project information in this section is based on local project reports, which are prepared annually; analyses of the national Water Quality Evaluation Project at North Carolina State University; and personal interviews by phone or in person with local project officials.
13. A part of the watershed extends slightly into Kentucky, though the lake itself is entirely in Tennessee. In some listings this project is shown under both States since the project involved interstate cooperation. It is frequently difficult to administer programs even across county boundaries, but in this case officials were able to conduct the project successfully on a bi-State basis.
14. C. Edwin Young and Frank A. Teti, *The Influence of Water Quality on the Value of Recreation Properties Adjacent to St. Albans Bay,* Vermont (Washington, DC: Economic Research Service, USDA, 1984). p. 25.

Report on the Rural Clean Water Program
Prepared for the
Soil and Water Conservation Society
by Charles E. Little.
Kensington, Maryland 20895
Completed by SWCS under Project
Agreement No. 68-3A75-7-7
U.S. Department of Agriculture
May 1989